in Bornholm alone produces some twenty thousand salmon, is carried on throughout the year, but is most successful in winter. M. Fendersen has shown that almost every river of Iceland has its peculiar form of salmon, and that each of these forms frequents, during its growth, the seas adjacent to its native river.

EMBRYOLOGY.

Notes on the Development of Ampullaria depressa, Say.—During last spring Mr. Jos. Willcox sent a lot of the large ova of the above-named species of this interesting genus from Florida to my colleague, Professor Leidy, who very kindly placed some of the material at my disposal for study. These ova were placed in the conservatory connected with the Biological School, where they underwent development in an apparently normal way, at the surface of the water in aquaria in which Algæ are kept. It was found that the egg must not be immersed in the water; if immersed they are apparently asphyxiated. This corresponds with what Mr. Willcox has related to me in regard to the habits of oviposition of this fresh-water mollusk; the parent animal creeping, according to his observation, to the surface upon the stems of water plants, and after having reached the portions of the plants which rise above the water, the large eggs are deposited in a single layer on the leaves exposed to the air. Whether a glutinous covering invests the freshly laid ova I was not informed; it is certain, however, that the ova are firmly secured by a transparent glutinous substance to the large leaves of the water plants upon which they are found. Each of the spherical ova adheres to this glutinous matter, and its inferior side rests in a concave depression on the adhesive matter which forms a pretty thick layer on the leaves over the area covered by a brood of eggs. The broods vary in number, and, if the lots which I had under examination were undisturbed before reaching my hands, they may reach the number of forty or more, lying in a group about an inch wide and three or four inches long. Semper found seventy to eighty eggs in a single brood of *A. polita*.

The color of the living ova is pinkish by transmitted, but lighter by reflected light, because of the white of the calcareous shell. The pinkish color is not due to the presence of any coloring matter in the sub-

stance the egg shell itself, but is owing to the reddish brown color of the albumen which invests the ovum proper.

The diameter of the entire ovum is about one-fifth of an inch. This measurement includes the secondary egg-envelopes, *i.e.*, the calcareous shell and the albumen. The ovum proper is quite small, measuring only two-thirds of an millimeter or one thirty-seventh of an inch in diameter.

The structure and physiological relations of the shell, albumen, air-vesicle and ovum are complex; quite as much so, in fact, as in the egg of the common fowl, from which Ampullaria is of course exceedingly remote. There is even a striking resemblance between the bird's egg and that of Ampullaria in a number of respects. These are found in the common feature of an air space, a peripheral more liquid and a central more viscid mass of albumen, in which the ovum is embedded in both cases. I have been unable, however, to make out distinct chalazæ in the eggs of Ampullaria.

The size of the youngest segmented ova was two-thirds of a millimeter, which is unusual for the egg of a gastropod and is not greatly exceeded by the ova of most forms; the more usual dimensions being far below this, though in some it is probably much greater, as in Bulimus, for example, judging from the size of the shell.

The great size of the egg makes it certain that development proceeds by epiboly, the germinal or animal pole of the egg being probably marked by a blastodisk at an early stage. The early stages, of course, were not observed by me, having been passed over long before the ova came into my possession. A very large yolk was present in the youngest stages and the yolk substance was homogeneous and not granular. The relations of the yolk and the development of the walls of the mid-gut are of considerable interest as revealed in sections of entire embryos.

The account given by Semper of the development of *A. polita* Derhayes, is very incomplete as respects the early stages. The entire egg of *A. polita* is much smaller than that of *A. depressa*, measuring only three millimeters instead of five as in the latter. But there evidently remains a large yolk mass, as shown by one of Semper's figures, in which there is also represented a hemispherical cap, the blastoderm probably, composed of vesicular cells. One of his figures, showing four blastomeres, gives one the impression at first that cleavage is total, but this view is irreconcilable with the next figure, and if I have understood his text properly he has recorded nothing which is in conflict with the conclusion that the segmentation was partial; since

there is a large yolk mass represented in all of his figures of the latter stages.

In other respects the development of *A. depressa* and *A. polita* are very similar. The mid-gut has its walls greatly thickened in both cases. This is due to the hypertrophy of its constituent endodermal cells, which are evidentally occupied, as shown in sections of the latter stages, with the work of appropriating the yolk which still dilates the intestine. The yolk is absolutely without nuclei of its own, and is brownish-yellow in color. The dilated portion of the intestine bulges the body-wall outward into a hump-like prominence between the edge of the young shell and the back of the head of the embryo. There is a simple ctenidium or gill developed in the pallial chamber, and the young paired "hepatic" diverticula are greenish in color. The foot bears an operculum on its dorsal side long before the young animal leaves the egg-shell. No teeth seem to be differentiated on the radula in the older larva, one and a half millimeters in diameter. The foot, and a slight fold above the mesopodium and between the latter and the head, are ciliated, as well as the thickened epidermis about the mouth and the tips of the tentacles. The muscular mass underlying the radula, the otocysts and eyes, are well developed. The latter show pigment at this time. The yolk in the intestine has in my oldest stages grown quite small in amount, and causes only a slight projection of the body wall behind and above the head. The whole embryo rotates within the reddish albumen in which it is embedded, on account of the action of the cilia covering the foot. From the dimensions of two-thirds millimeter the embryo grows until it fills out the whole of the space of five millimeters in diameter inclosed by the egg-shell. In the course of this process the albumen surrounding the embryo is probably swallowed by the young snail and appropriated by the hypertrophied amœboid cells of the intestinal wall.

The air-vesicle is always at the upper pole of the egg, and forms a lenticular cavity just within the calcareous shell. It doubtless has to do with the respiration of the embryo, and recalls in a striking way the *vesicula aeris* of the bird's ovum, except that it has a different position, and does not seem to be separated from the albumen by a membrane.—JOHN A. RYDER.

Development of Crangon vulgaris.[1]—Dr. Kingsley's third paper on the development of this crustacean has just been published. His general conclusions are interesting as pointing out the presence of

[1] Bulletin Essex Institute, Vol. XXI., 1889, plates I.–III.

structures indicative of wider or more general affinities with other Bilateralia. The summary given below is in his own words.

1. The arthropod egg is not to be regarded as centrolecithal and having a superficial segmentation, but as having a central segmentation, the blastoderm being formed by migration of the resulting cells to the surface.

2. The primitive groove in the arthropods is a modified blastopore, and the absence of invaginated entoderm in some forms is to be explained by Cope's and Hyatt's theory of acceleration and retardation.

3. In Crangon the anus occupies the position of the blastopore.

4. In Crangon and many other crustacea the young germinal area is actually larger than the much older embryo.

5. All of the appendages belong to the primitively post-oral series, and the appendages move forward more rapidly than the corresponding ganglia.

6. There are indications of segmental sense organs in every segment of the body.

7. The alimentary tract proper is nearly, if not entirely, formed from the proctodeal and stomodeal invaginations, the entoderm giving rise to nothing but the liver.

8. The green gland is mesodermal in origin, and belongs to the category of segmental organs.

9. The genital ducts are modified nephridia.

10. The nauplius is an introduced feature, and represents no adult ancestral condition in the crustacean phylum.

Development of Sepia officinalis.—M. L. Vialleton concludes in the *Annales des Sciences Naturelles* (Tome VI., Nos. 4, 5, 6), an important contribution to the knowledge of the early phases of the development of *Sepia officinalis*, illustrated by six plates.

The formative vitellus in the Sepia is reduced to a laminæ at the pointed end of the yolk, and in this laminæ, directly after fecundation, a germinative central disc can be distinguished The first plane of segmentation is meridional, and divides the disc into five equal parts. Two and finally four secondary meridional divisions finally divide it into eight unequal segments. The polar globules place themselves near the first furrow at some distance from the centre of the egg. These eight segments have the value of macromeres. In the fourth stage the two inferior segments are divided equatorially, the others meridionally, dividing off two micromeres, so that the blastoderm at this stage has fourteen macromeres and two micromeres. By a further bipartition,

the blastoderm comprehends twelve micromeres and twenty macromeres, eight of the former being parted from eight of the micromeres. By this method of parting off micromeres, the latter at the end of segmentation are more than three hundred in number, and form a plaque with the smaller micromeres in the centre. The peripheric zone of the blastoderm occupied by the macromeric segments or blastocones, becomes transformed into a special thin bed which intercalates itself between the embryo and the vitellus, and is called by Vialleton the perivitelline membrane. Meanwhile a division of the micromeres or blastomeres perpendicular to their height produces a deeper layer of cellules—a mesoderm. Thus the egg at this stage consists of: (1) the ectoderm, which forms a circular plate composed in its centre of a single layer of cellules, but around its edge of several layers, produced by delamination at the expense of the superficial layer. (2) Of the mesoderm (*pars*) represented by the deeper beds of the borders of the blastoderm; and (3) by the perivitelline membrane or primitive endoderm. The border of the blastoderm then parts into a clear portion which becomes the vitelline sac, and an interior embryonal area. By secondary determinations, the ectoderm afterwards furnishes additional elements to the mesoderm. The entoderm, usually formed at an early stage, does not show itself in the Sepia until the eyes and pallial folds have been sketched out, and its development is very rapid, and seems to be formed at the expense of the perivitelline membrane.

PSYCHOLOGY.

The Psychic Life of Micro-Organisms.[1]—M. Alfred Binet, one of the most eminent representatives of the French School of Psychology, has presented in the above work the most important results of recent investigations into the world of micro-organisms. The subject is a branch of comparative psychology little known; as the data of this department of natural science lie scattered for the most part in isolated reports and publications, and no attempt has hitherto been made to collate and present them in a systematized form.

[1] THE PSYCHIC LIFE OF MICRO-ORGANISMS. A Study in Experimental Psychology. By Charles Binet. Translated from the French by Thomas McCormack, with a preface by the author written especially for the American edition. Chicago: 1889. The Open Court Publishing Company. Cloth, 75 cents. Paper, 50 cents.